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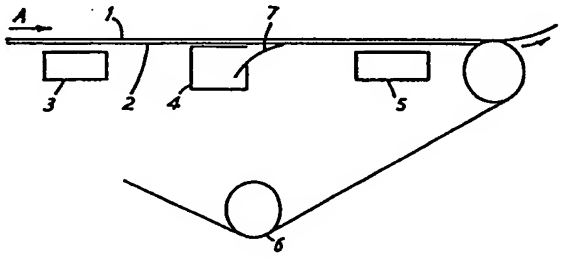
(71) Applicant: The Wiggins Teape Group Limited, P.O. Box 88 Gateway House Basing View, Basingstoke Hampshire RG21 2EE (GB)

(72) Inventor: Jenkins, Stanley Noel, 72 Althorp Drive Penarth, South Glamorgan Wales (GB)
Inventor: Willis, Anthony John, 16 Jerome Close, Marlow Buckinghamshire (GB)
Inventor: Radvan, Bronislaw, 24 The Meadows, Flackwell Heath Buckinghamshire (GB)

(74) Representative: Bridge-Butler, Alan James et al, G.F. REDFERN & CO. High Holborn House 52/54 High Holborn, London WC1V 6RL (GB)

(54) Method of and apparatus for applying a liquid composition to a fibrous web.

(57) A method of applying a liquid composition to a moving fibrous web including forming a moving wet-laid fibrous web(1), partially draining the web and then applying a liquid composition by causing it to flow along a curved surface (7) adjacent the web (1) and in the direction of movement thereof, a foraminous material (2) moving at the same speed and in the same direction of movement of the web (1) being interposed between the surface (7) and the web (1) so that the material is applied to the web (1) through said foraminous material (2).



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METHOD OF AND APPARATUS FOR APPLYING A LIQUID COMPOSITION TO A FIBROUS WEB

The present invention relates to a method and apparatus for applying a liquid composition to a fibrous web, for example a paper web.

When it is desired to apply a coating to a web of paper or non-woven sheet material, or to impregnate it with a liquid, or with a suspension, the web is usually first wet-laid and dried before passing through a coating head where the coating composition is then applied. Once the coating has been applied it is necessary to dry the web again. This means that two drying operations are involved when coating compositions are applied in a conventional manner with a resultant high and expensive energy consumption.

As an alternative to coating a paper web, in order to improve the printing surface and absorption of the printing ink and to give a higher finish and greater opacity to a paper web, it is usual to add mineral fillers or loadings to the papermaking stock. The amount added depends on the purpose for which the paper will be required and the extent to which the loading will be retained on the paper-machine. However, often less than half the loading added with the stock at the wet end reaches the press section of the machine, the remainder being lost by drainage through the wire. Common loadings are kaolin which provides a more respective surface for printing ink and titanium dioxide which is effective for opacity and whiteness. Titanium dioxide in particular is expensive and it is therefore advantageous that as much as possible of that applied is retained in the web, and that it is retained in a well-dispersed state. The two requirements

are to some extent contradictory, since it is easier to retain the loading in a coarse, or flocculated condition, than if it is well-dispersed.

It is an object of the present invention to produce a method and apparatus which will satisfy the above requirements for applying liquid composition to a fibrous web so that it is retained in the web to an adequate or improved extent and which overcomes, at least in part, the drawbacks associated with conventional methods.

It has now been found that the above described problems can be eliminated or at least reduced by applying a liquid composition to a wet-laid partially drained fibrous web.

According to the present invention a method for applying a liquid composition to a fibrous web includes forming a moving wet-laid fibrous web, partially draining the web and then applying a liquid composition by causing it to flow along a curved surface adjacent the web and in the direction of movement thereof, a foraminous material moving at the same speed and in the same direction of movement of the web being interposed between the surface and the web so that the material is applied to the web through said foraminous material.

Thus, the liquid composition can be applied to the lower surface of the web and could conveniently include wet-laying the fibrous web onto the said foraminous material which is provided beneath it and which is interposed between the web and the curved surface.

Alternatively or additionally the liquid composition can be applied to the upper surface of the web and thus this may include wet-laying the fibrous web onto a foraminous

material provided beneath it and applying the liquid composition from the curved surface downardly through a second foraminous material moving at the same speed and in the same direction as the web.

Preferably the process includes moving the coated web past a vacuum drainage device and providing a foraminous material moving at the same speed and in the same direction of movement of the web between the coating web and the device.

The vacuum drainage device can be located on the same side of the web as the curved surface or it can be located on the opposite side of the web in which case a moving foraminous material is provided on both sides of the web.

Again, if desired, vacuum drainage devices can be provided on both sides of the web.

The foraminous material is preferably a fine wire mesh web, for example, of the kind used as a Fourdrinier wire.

Thus it will be appreciated that the foraminous material can, indeed, be the Foudrinier wire on which the fibrous web is initially formed if the liquid material is to be applied from beneath and an additional wire of a similar kind is provided above the wet-laid fibrous web if the liquid material is to be applied from above.

The invention also includes apparatus for applying a liquid composition to a moving fibrous web according to the method set forth above and which comprises a reservoir having an outlet and a curved surface extending from and adjacent to the outlet, means for discharging a liquid composition from the outlet to flow along the

curved surface adjacent the web in the direction of movement thereof and a foraminous material arranged to move at the same speed and in the same direction of movement as the web interposed between the web and the curved surface, and through which the liquid composition is applied to the web.

The curved surface can be provided in various ways, thus it can be in the form of a curved blade extending from the reservoir or it could be defined by the surface of a rotating cylinder. Yet again, it could be provided at the outlet from a delivery passage connected to the reservoir.

Means can be included for controlling the rate of delivery of the liquid composition to the curved surface and when the surface is provided as the outlet for the delivery passage the means for controlling the rate of delivery could include means for adjusting the dimensions of the delivery passage.

The curved surface may be located beneath the fibrous web which is supported on foraminous material in the form of a Fourdrinier wire.

Alternatively the curved surface can be located above the fibrous web and a further foraminous element is then located between the curved surface and the upper side of the web.

With this arrangement the said upper foraminous element can be formed by the surface of a rotating cylinder within which the curved surface is located.

If desired curved surfaces can be provided on both sides of the fibrous web for applying layers of liquid compositions above and below the web through their associated foraminous materials thus providing coatings on both sides of the web.

The present invention may be used to apply several different compositions to a paper web for example titanium dioxide for improving opacity, kaolin for printability and colour developer material and capsules containing colour formers for use in pressure sensitive copying materials.

Applying coatings to the underside of a paper web may provide good one-sidedness i.e. the coating remains concentrated to the side on which it is applied. Also the coating is particularly even because the wire helps distribute the coating composition and also protects the fibrous structure of the web and minimises disruption of the web.

The apparatus may also include a vacuum drainage device which can draw moisture from the web through the foraminous material downstream of the curved surface and on the same side of the web.

Alternatively or additionally a second foraminous material can be provided on the opposite side of the web from the curved surface and a vacuum drainage device can be included which is arranged to draw moisture from the web on the same side as the second foraminous surface.

Again therefore foraminous materials can be provided on both sides of the web and vacuum drainage devices on both sides of the web which draw moisture through their respective foraminous materials.

It might be expected that after applying the coating and as the web moves over the vacuum device to complete the draining process, much of the coating will be sucked out but it has been found that this is not the case, any coating that is removed however can be re-cycled back to the reservoir or reservoirs for re-application.

The present method and apparatus are also suited to applying additional loadings to the paper web. This enables loading levels above those already present in the papermaking stock to be added. A completely unloaded stock may also be used, with the advantage that it need contain less, if any, retention aid chemicals. The loadings are then added in a relatively concentrated suspension after the stock has been partly drained, and are still well retained. The method thus offers the paper maker an additional degree of freedom in choosing the chemical composition of the stock with less regard to the retention of loadings.

It will also be appreciated that because the process of the invention obviates the need to subject the subsequently dried sheet to an off machine coating operation, sheet strength need not be predetermined by the need to withstand the stresses of coating. As a result, and unless a strong sheet is required for other purposes, furnish costs can be reduced by increasing the non-fibrous filler content.

The present method and apparatus also eliminates the need for the additional drying stage essential for off machine coating.

It will also be appreciated that by using the method and apparatus of the present invention one coating can be applied to the underside of the wet web and a further coating applied to the upper side. This is particularly useful when manufacturing pressure sensitive copying paper where the colour developer (CF) coating may be applied by means of the present invention on one side of the paper and the colour former (CB) coating applied further down the paper machine on the other side of the paper to produce a CFB sheet i.e. tandem coating of CF/CB may be achieved on the same machine.

The invention can be performed in various ways and a number of embodiments will now be described by way of example and with reference to the accompanying drawings in which :

Figure 1 is a diagrammatic side view of underwire coating apparatus according to the present invention;

Figure 2 is a diagrammatic side view in more detail of part of the underwire coating apparatus shown in Figure 1;

Figure 3 is a diagrammtic side view of over wire coating apparatus according to the present invention;

Figure 4 is a diagrammatic side view of an alternative arrangement with a vacuum device above the web;

Figure 5 is a diagrammatic side view of another alternative arrangement;

Figure 6 is a diagrammatic side view of apparatus for coating both sides of the web; and

Figure 7 is a diagrammatic side view of another arrangement for applying a coating to the upper surface of the web.

A method and apparatus for coating a paper is shown in Figure 1. A wet-laid paper web 1 is supported on a foraminous material provided by a Fourdrinier wire 2 travelling in the direction shown by arrow A. Water drains out of the web 1 through the wire 2. This draining process is speeded up as the web 1 passes over a vacuum device in the form of a vacuum box 3 of known kind in the paper making industry and which removes more water from the web 1. From the vacuum box 3 the web 1 then passes over a coating device 4 located beneath the wire 2. This coating device 4 feeds coating composition along a curved blade 7 onto the underside of the wire 2. The hydrostatic pressure causes the coating to be absorbed into the web 1. After passing over the coating device 4 the web 1 passes over a further vacuum box 5, where more water is removed through the wire 2 and from here onto the dry end of the paper machine.

Figure 2 shows in more detail the construction of the coating device 4 and which is located under the Fourdrinier wire 2 which supports the partially drained wet paper web 1. A liquid coating composition is fed into a reservoir 8 via an inlet pipe 9. Baffles 11 in the reservoir 8 even out the flow of coating composition as shown by the arrows 13. The coating composition then flows out of a nip 14 and along a curved blade 7. The liquid coating composition is absorbed into the under side of the web as a result of the hydrostatic pressure which builds up at the point of contact between the blade 7 and the underside of the wire 2. Bleed screws 10 allow the pressure in the reservoir 8 to be adjusted to control the rate of flow.

In the arrangement shown in Figure 3 a wet laid paper web 1 is supported on a Fourdrinier wire 2 travelling in the direction shown by arrow A. Water drains out of the web 1, through the wire 2. This draining process is speeded up as the web 1 passes over a vacuum box 3 which removed more water from the web 1. From the vacuum box 3 the web 1 then passes under a coating device 4 which is positioned above the wire 2. This coating device 4 feeds a liquid coating composition along a curved blade 7 onto the topside of the web 1 through a foraminous material in the form of a wire mesh 20 which is interposed between the web 1 and the coating device 4. The wire mesh 20 is supported on guide rolls 21. The liquid coating composition is absorbed onto the web as a result of the hydrostatic pressure which builds up at the point of contact between the blade 7 and the wire 2. After passing under the coating device 4 the web 1 passes over a further vacuum box 5 beneath the web where more water is removed through the wire 2 and from here onto the dry end of the paper machine.

The following examples of coated web were made on this type of apparatus.

Example 1

This example illustrates the use of the present method and apparatus as shown in Figure 1 to apply a coating of clay material to the underside of a paper web in order to improve the printability of the paper. A 10% slurry of kaolin (sold under the trade name Dinkie A) was made up containing 8% w/w solution of carboxy methyl cellulose (sold under the trade name Finifix) as binder. This was then coated onto a 65 gm^{-2} base sheet using the underwire coating method.

After coating the percentage Ash was measured to determine how much kaolin had been retained in the web.

Run	Grammage	% Ash
1	64.9	17.1
2	66.1	21.5
3	65.3	19.4
4	64.3	22.4
5	69.8	22.9
6	68.9	20.6

There was no visible disruption of the web or patchiness of coating.

% Ash is obtained by burning the paper and measuring the amount of mineral matter (ash) which remains. This generally varies from less than 1% (which is the natural mineral matter present in the fibre) to as much as 30% when clay has been added. The % Ash figures obtained in the above example illustrate that a high amount of kaolin has been retained in the web.

Example 2

This example illustrates the use of the present method apparatus as shown in Figure 1 to apply a loading of titanium dioxide to the underside of a paper web in order to improvide the opacity of the sheet.

A well-dispersed mix of 45% solids of titanium dioxide (rutile grade) was impregnated into a paper web of approximately 65-70 gm^{-2} at 10 $lmin^{-1}$.

The following results were obtained.

Run	Grammage	% Ash
1	70.8	26.7
2	65.1	24.3
3	70.3	32.0
4	72.8	33.5

There was no visible disruption of the web, the % Ash providing an indication of the amount of titanium dioxide retained in the web. The paper appeared only slightly two-sided, demonstrating that the suspension of titanium dioxide impregnated well the whole thickness of the web.

Example 3

This example illustrates the use of the present method and apparatus as shown in Figure 1 to apply a coating of capsules and clay to the underside of a paper web in order to prepare a self-contained pressure-sensitive copying material.

A mix of 3% active solids (See Table 1) was coated onto a 35gm^{-2} paper web using the underwire coating box.

Table 1

Capsules	7.7 kg at	19.6% solids
Silton clay	1.5 kg	" "
Wheatstarch	0.6 kg	" "
Water	90.2 kg	" "

In this case the amount of coating retention was estimated by calculating the amount of mix retained in the web. This was done by measuring samples taken before and after the coating box and comparing this figure with the weight of mix applied to the web.

The results are shown in Table 2. The machine speed is 1.33 ms^{-1} for all runs.

Table 2

Run	1	2	3	4	5
Mix Flow rate ($lmin^{-1}$)	0	10	10	10	10
Applied Mix grammage (gm^{-2})	0	9.9	9.9	9.9	9.9
Actual Grammage (gm^{-2})	35.5	45.0	42.0	38.0	36.5
Retention (%)	-	96	66	25	10
CI (48 hr)					
Topside	-	45.0	44.0	55.0	58.5
Wireside	-	25.0	39.5	45.0	50.5
Comments	Base	No vacuum	Vacuum line on Rotabelt off	Vacuum line off Rotabelt on	Vacuum line on Rotabelt on

Table 2 (cont.)

Run	6	7	8	9
Mix Flow rate ($lmin^{-1}$)	12	12	15	15
Applied Mix grammage (gm^{-2})	11.8	11.8	14.8	14.8
Actual Grammage (gm^{-2})	45.0	38.0	46.0	39.0
Retention (%)	81	21	71	24
CI (48 hr)				
Topside	44.0	57.5	41.5	55.5
Wireside	24.0	49.5	22.0	47.5
Comments	No Vacuum	Vacuum line on Rotabelt on	No vacuum	Vacuum line on Rotabelt on

It was found that better retentions were obtained when no vacuum was applied after the coating device i.e. runs 2, 6 and 8.

The calender intensity (CI) test in this case involves passing strips of the paper under test through a laboratory calender to rupture the capsules and thereby produce a colour on the test strip, measuring the reflectance of the thus coloured strip (I) and expressing the result ($^{I}/_{I_0}$) as a percentage of an unused control strip (I_0). Thus the lower the calender intensity value ($^{I}/_{I_0}$) the more intense the

developed colour.

The CI value of both the topside and the wire side was measured after 48 hours. A low value indicates high intensity of colour developer. Clearly from the results more colour reacting components are concentrated on the wire side and particularly good results are obtained on the wire side when no vacuum is applied after the coating box. In this case, it is an advantage to have the active components concentrated on one side of the paper, (i.e. "coated") rather than distributed throughout its thickness (i.e. impregnated).

Example 4

This example illustrates the use of the present method and apparatus as shown in Figure 1 to apply a coating of colour developer to the underside of a paper web to produce a colour developer (CF) sheet for use in pressure-sensitive copying materials.

A standard CF mix was prepared and coated onto a 48gm^{-2} base paper web at solids contents of 5, 10 and 20%. The pH of the mix was 10.5 except on runs 8, 10 and 11 where it was 12.5. The dryness of the web to be coated was also varied by altering the vacuum from 6KPa to 18kPa.

The machine speed in all cases was 1.33 ms^{-1}. The smoothness of the web was improved by calendering at 26.27 kNm^{-1} (150 PLI). Runs 13 to 19 were also calendered at 70 kNm^{-1} (400 PLI).

The results obtained are shown in Table 4.
All the runs illustrated the good two-sidedness of this coating technique i.e. the coating is concentrated on the wire side of the web. In general, a higher percentage of mix is retained on the base when the base paper web at the point of application contains less water.

In this case the calender intensity (CI) test involves superimposing strips of paper coated with encapsulated colour former solution onto a strip of the coated paper under test, passing the superimposed strips through a laboratory calender to rupture the capsules and thereby produce a colour on the test strip, measuring the reflectance of the thus coloured strip (I) and expressing the result ($^{I}/_{I_o}$) as a percentage of an unused control strip (I_o). Thus the lower the calender intensity value ($^{I}/_{I_o}$) the more intense the developed colour.

TABLE 4

Run Nos.	1(Base	2	3	4	5	6
Mix solids (%)	--	10	10	10	10	10
Applied mix grammage (gm^{-2})	--	54.8	54.8	54.8	54.8	54.8
Retained mix grammage (gm^{-2})	--	11.6	10.0	19.1	7.7	6.8
Retention (%)	--	21.2	18.2	34.8	14.1	12.4
CI (2 mins) Face	97.8	62.3	64.6	61.4	67.6	69.3
Back	97.2	80.4	84.5	80.0	85.9	86.2
CI (48 hrs) Face	94.2	60.1	60.7	55.3	64.0	66.0
Back	98.7	77.1	81.4	76.6	82.2	83.2
Adhesion Face	90	20	20	20	50	50
Back	90	70	80	60	70	80
Mix flow rate (lm^{-1})	--	15	15	15	15	15
Vacuum applied before coating head (kPa)	16	18	12	18	18	12
Base moisture at coating head (%)	--	82.6	85.5	82.4	81.8	85.5
Vacuum applied after coating head (kPa)	Vacuum Vacuum	off line	on	8	18	18
Base moisture at touch (%)	--	83.3	83.0	84.1	78.4	78.1

TABLE 4 (cont.)

Run Nos.	7	8	9(Base)	10	11	12
Mix solids (%)	10	10	--	10	10	5
Applied mix grammage (gm^{-2})	54.8	55.7	--	55.7	55.7	43.9
Retained mix grammage (gm^{-2})	3.5	7.0	--	5.6	3.9	4.2
Retention (%)	6.4	12.8	--	10.1	7.0	9.6
CI (2 mins) Face	73.3	68.9	97.1	68.9	68.9	72.8
Back	95.5	85.4	96.1	91.5	95.4	86.6
CI (48 hrs) Face	70.5	64.4	95.0	64.1	66.5	68.2
Back	93.6	80.6	93.9	88.3	91.0	83.0
Adhesion Face	60	40	90	40	40	70
Back	90	90	90	90	80	90
Mix flow rate (lm^{-1})	15	15	--	15	15	20
Vacuum applied before coating head (kPa)	6	18	18	13	6	18
Base moisture at coating head (%)	89.6	82.8	82.3	83.9	90.9	--
Vacuum applied after coating head (kPa)	18	18	16	18	18	18
Base moisture at touch (%)	79.4	79.0	79.5	79.7	79.7	76.9

TABLE 4 (cont.)

Run Nos.	13(Base)	14	15	16	17	18	19 (Base)
Mix solids (%)	--	5	5	20	20	20	--
Applied mix grammage (gm^{-2})	--	43.9	43.9	117.2	117.2	117.2	--
Retained mix grammage (gm^{-2})	--	3.6	2.2	12.6	11.2	5.4	--
Retention (%)	--	8.2	5.0	10.8	9.6	4.6	--
CI (2 mins) Face	96.1	73.5	78.4	65.4	62.3	68.7	96.2
	*(96.1)	(71.4)	(75.4)	(59.0)	(57.4)	(65.6)	(95.5)
Back	95.2	93.5	93.9	82.1	85.8	92.8	95.4
	(97.7)	(93.1)	(95.9)	(83.1)	(88.7)	(93.9)	(95.9)
CI (48 hrs) Face	92.8	70.1	74.4	60.2	58.2	67.6	93.1
	(93.6)	(69.8)	(72.8)	(53.4)	(53.8)	(63.2)	(93.0)
Back	93.4	90.0	93.1	76.8	81.4	87.6	92.6
	(94.4)	(87.0)	(93.0)	(77.8)	(82.2)	(89.4)	(93.4)
Adhesion Face	80	60	60	40	30	50	80
Back	80	90	90	80	80	100	90
Mix flow rate (lm^{-1})	--	20	20	15	15	15	--
Vacuum applied before coating head (kPa)	18	12	6	18	12	6	18
Base moisture at coating head (%)	81.4	86.0	88.9	80.9	85.4	90.2	82.4
Vacuum applied after coating head (kPa)	18	18	18	18	18	18	17
Base moisture at touch (%)	78.3	77.0	79.1	76.8	79.1	79.7	80.9

* brackets indicate samples calendered at 400PLI

Figure 4 shows a construction which is employed with a Fourdrinier paper machine and similar reference numerals are used to indicate similar parts as in the previous Figures. In the construction shown the paper making stock was deposited on the Fourdrinier wire 2 from a head box of known design (not shown) and was drained by foils and vacuum boxes (not shown) to form a wet web 1 to a condition when its surface no longer appears fluid (usually known as the "dry line").

A coating device 4 comprises a reservoir chamber 8 which is fed from a delivery pipe 40 by a pump 41. The pump 40 delivers a metered quantity of liquid coating composition. The material passes from the reservoir into a delivery passage 42 which has an adjustable slot 43 controlled by an adjustable slide 44. The slot 43 leads to a curved delivery surface 45 with a radius of approximately 2 cm followed by an approximately horizontal surface 46. Two vacuum devices 5 are provided beneath the Fourdrinier wire downstream of the coating device 4 and an additional vacuum device 47 is provided above the web.

As will be seen an additional foraminous element in the form of a wire mesh 20 similar to that shown in Figure 3 is provided above the web. This wire mesh 20 is interposed between the vacuum device 47 and the web 1 and is carried on an inlet roll 48, a drive roller 49, a stretch roll 50 and a tensioning roll 51. The whole assembly is mounted on a frame (not shown) which can be lifted and lowered by pneumatic means (not shown).

Example 5

This example was made on apparatus as shown in Figure 4. The stock used to form the web 1 consisted of equal proportions of softwood and hardwood sulphate pulps, refined together to a wetness of 60° Schopper-Riegler. The coating mixes used were two of the compositions used in the manufacture of carbonless copying papers. In the first run a "C.F." mix, that is a mix consisting essentially of a reactive clay together with a binder was used. In runs 2 to 5 a mix was used consisting essentially of a mixture of reactive clay with encapsulated colour-forming substance, and a binder.

The technique for manufacture and preparation of these materials are known and do not form part of the present invention. Both mixes were diluted with water to the solids contents indicated in the Tables 5 and 6 below. The speed of the machine was 18 metres per minute in all cases, other essential conditions and the resulting coating weights are indicated in the Tables.

Table 5

Run Nos.	1 . 2 . 3 . 4
Base Grammage g/m^2	74 54 54 40
Coating Mix:	
solids content % by weight	3 3 3 3
rate of flow l/min. m. width	31 30 27 30
Vacuum	
in Box 7	low - just sufficient to prevent transfer web
in Box 8	high - (approx. 6" Hg.).
in subsequent boxes under the Fourdrinier wire	low - (approx. 2" Hg.).
Coating weight g/m^2	26 8 6 8

Table 6

Run No.	5
Base Grammage g/m^2	45
Coating Mix	
solids content % by weight	3
rate of flow l/min. m. width	30
Vacuum	
in Box 7	High - (approx. 6" Hg.)
in Box 8	Zero
in subsequent boxes	Moderate to High (3" - 8" Hg.).
Coating Weight g/m^2	9

Samples of the coated web were taken off the downstream part of the Fourdrinier wire 2 and dried by contact with a rotary electrically heated processing drier. The uniformity of the coating, and the degree of penetration of the coating mix into the web were judged visually after the clay samples were passed between the rolls of a calender at a linear pressure of 400 lbs. per square inch, and the colour-forming reaction took place. The uniformity was judged acceptable, and the colour was seen to have developed on the coated side of the web only.

Figure 5 shows an arrangement for applying a liquid material to the upper surface of a web and again the same reference numerals are used for similar parts as shown in Figure 4. In this construction however the liquid material was delivered through a perforated pipe 52 which acts as a reservoir and the material emerges from the pipe through a series of openings 53 into a pond 54 formed between a transversely extending metering blade 55 and an applicator roll 56. Coating material from the pond 54 is metered onto the roll 56 by the blade 55. The applicator roll 56 rotates in the direction of the arrow C and applies the coating to the upper surface of the web 1 through the wire 20.

Example 6

The stock coating mix and the machine conditions are the same as in Runs 2 - 4 of Example 5 and the results are shown in Table 6.

Again an even coating was obtained with the colour developing on the coated side only.

It will be understood that the choice of coating mixes used in the above examples does not limit the operation of the invention but was only used as an illustration and for the convenience of the use of the colour reaction to indicate the uniformity of and the position of the coating within the web.

Figure 6 shows an arrangement which combines the arrangements shown in Figures 4 and 5 and the same reference numerals are again used to indicate similar parts. The curved blade 55 is conveniently mounted on the vacuum box 47. This apparatus provides the facility of coating both sides of the web 1 at the wet-end of the paper making machine. It will be seen that a first coating is applied from beneath the web, vacuum then being applied from above the web through the second wire 20 by the vacuum box 47. The second coating is then applied from above the web through the wire 20 and vacuum applied by vacuum boxes located beneath the Fourdrinier wire 2.

Figure 7 shows another construction for applying the liquid coating composition to the upper side of the web and the same reference numerals are again used to indicate the same parts. In this construction the web 1 wet-laid on the Fourdrinier wire 2 moves in the direction of the arrow B over a roller 60 which rotates in the direction of the arrow D. Mounted for rotation above the roller 60 is a cylinder 61 which has a wire mesh surface and is driven to rotate in the direction of the arrow E. Located within the cylinder 61 is a reservoir pipe 67 which has a series of openings 63 through which liquid composition pumped into the pipe 62 can escape. The pipe 62 carries a transversely extending blade 64 which engages the inner surface of the drum 61 and forms a pond 65 into which the

liquid from the opening 63 is delivered. The liquid material is thus applied as a layer 66 to the upper surface of the web 1 through the wire mesh cylinder 61. Suitable vacuum devices can be provided either above and/or below the web downstream of the cylinder to provide the necessary drying effect.

CLAIMS

1. A method of applying a liquid composition to a moving fibrous web including forming a moving wet-laid fibrous web, partially draining the web and then applying a liquid composition by causing it to flow along a curved surface adjacent the web and in the direction of movement thereof, a foraminous material moving at the same speed and in the same direction of movement of the web being interposed between the surface and the web so that the material is applied to the web through said foraminous material.

2. A method as claimed in claim 1 in which the liquid composition is applied to the lower surface of the web.

3. A method as claimed in claim 2 which includes wet-laying the firbous web onto the said foraminous material which is provided beneath it and which is interposed between the web and the curved surface.

4. A method as claimed in claim 1 in which the liquid composition is applied to the upper surface of the web.

5. A method as claimed in claim 4 which includes wet-laying the fibrous web onto a foraminous material provided beneath it and applying the liquid composition from the curved surface downwardly through a second foraminous material moving at the same speed and in the same direction as the web.

6. A method as claimed in any one of preceding claims 1-4 in which liquid compositions are applied to both sides of the web.

7. A method as claimed in claims 1-6 which includes processing the coated web passed a vacuum drainage device and providing a foraminous material moving at the same speed and in the same direction of movement of the web between the coated web and the device.

8. A method as claimed in claim 7 in which the vacuum drainage device is located on the same side of the web as the curved surface.

9. A method as claimed in claim 7 in which the vacuum drainage device is located on the opposite side of the web to the coated surface and the moving foraminous material is provided on both sides of the web.

10. A method as claimed in claim 9 in which vacuum drainage devices are provided on both sides of the coated web.

11. A method as claimed in claims 1-10 in which the foraminous material is a fine wire mesh web.

12. Apparatus for applying a liquid composition to a moving fibrous web according to the method set forth in claim 1 comprising a reservoir having an outlet and a curved surface extending from and adjacent to the outlet, means for discharging a liquid composition from the outlet to flow along the curved surface adjacent the web in the direction of movement thereof and a foraminous material arranged to move at the same speed and in the same direction of movement as the web interposed between the web and the curved surface, and through which the liquid composition is applied to the web.

13. Apparatus as claimed in claim 12 in which the curved surface is provided on a curved blade extending from the reservoir .

14. Apparatus as claimed in claim 12 in which the curved surface is provided on the surface of a rotating cylinder.

15. Apparatus as claimed in claim 12 in which the curved surface is provided at the outlet from a delivery passage connected to the reservoir .

16. Apparatus as claimed in claims 13, 14 and 15 including means for controlling the rate of delivery of the liquid composition to the curved surface.

17. Apparatus as claimed in claim 16 when dependent on claim 10 in which the means for controlling the rate of delivery includes means for adjusting the dimensions of said delivery passage.

18. Apparatus as claimed in claims 12-17 in which the curved surface is located beneath the fibrous web which is supported on a Fourdrinier wire.

19. Apparatus as claimed in claims 12-17 in which the curved surface is located above the fibrous web and a further foraminous material is located between the curved surface and the upper side of the web.

20. Apparatus as claimed in claim 19 in which said upper foraminous material is provided on a rotating cylinder within which the curved surface is located.

21. Apparatus as claimed in claims 19 and 20 including curved surfaces on both sides of the fibrous web for applying layers of liquid compositions above and below the web through their associated foraminous materials.

22. Apparatus as claimed in claims 12-21 in which a vacuum drainage device is provided which can draw moisture from the web through the foraminous material downstream of the curved surface and on the same side of the web.

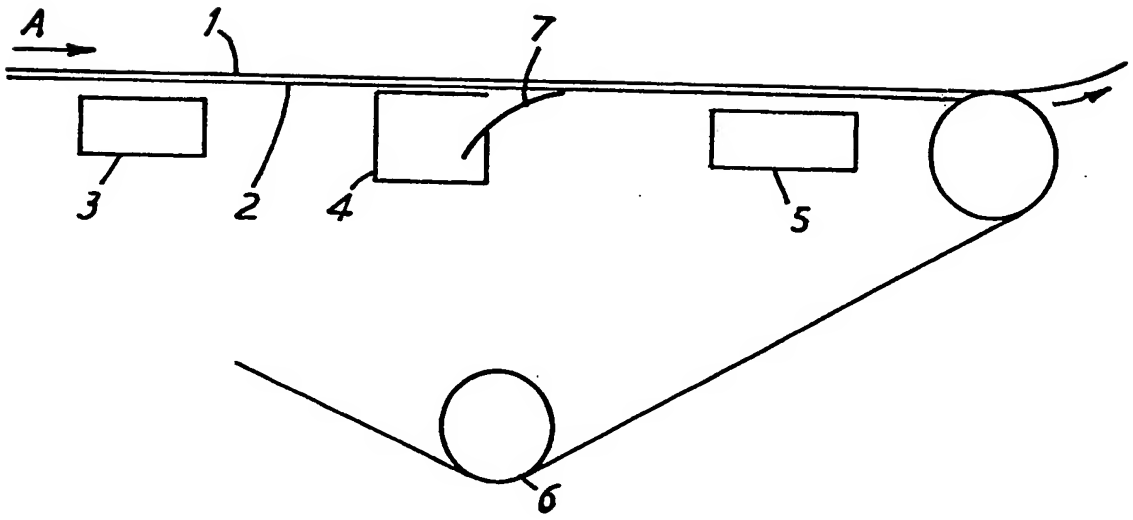
23. Apparatus as claimed in claims 12-21 in which a second foraminous material is provided on the opposite side of the web from the curved surface and including a vacuum drainage device arranged to draw moisture from the web on the same side as the second foraminous surface.

24. Apparatus as claimed in claim 23 including foraminous materials on both sides of the web and vacuum drainage devices on both sides of the web which draw moisture through their respective foraminous materials.

25. A method of applying a liquid composition to a wet-laid fibrous web substantially as described herein with reference to and as shown in the accompanying drawings.

26. Apparatus for applying a liquid composition to a wet-laid fibrous web according to the method set forth in claim 1 and substantially as described herein with reference to and as shown in the accompanying drawings.

FIG.1



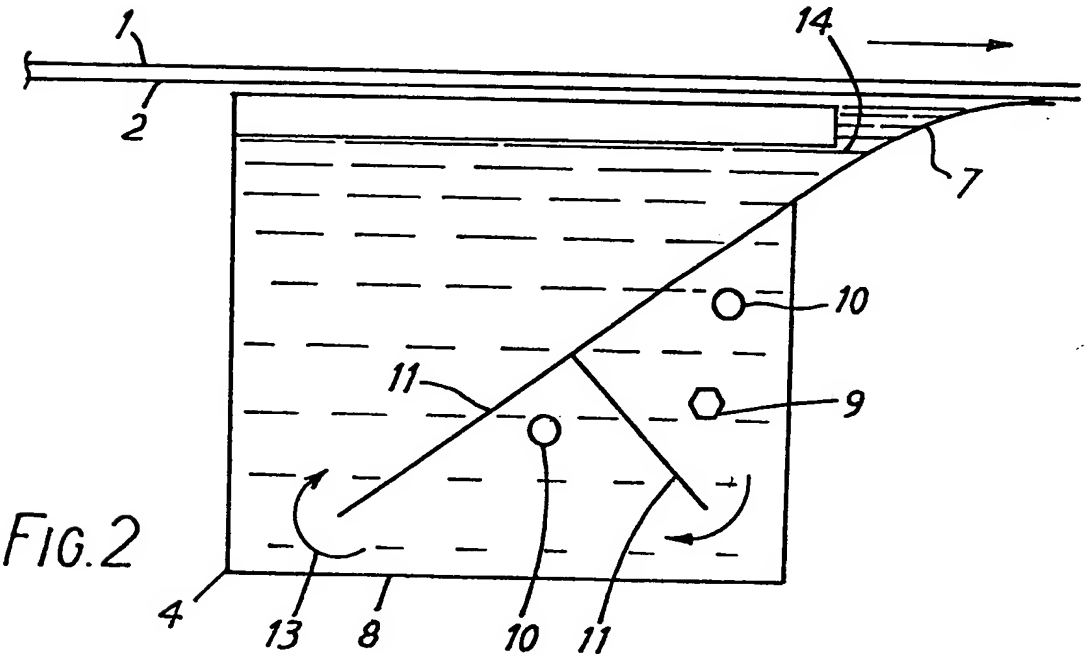


FIG.2

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FIG.3

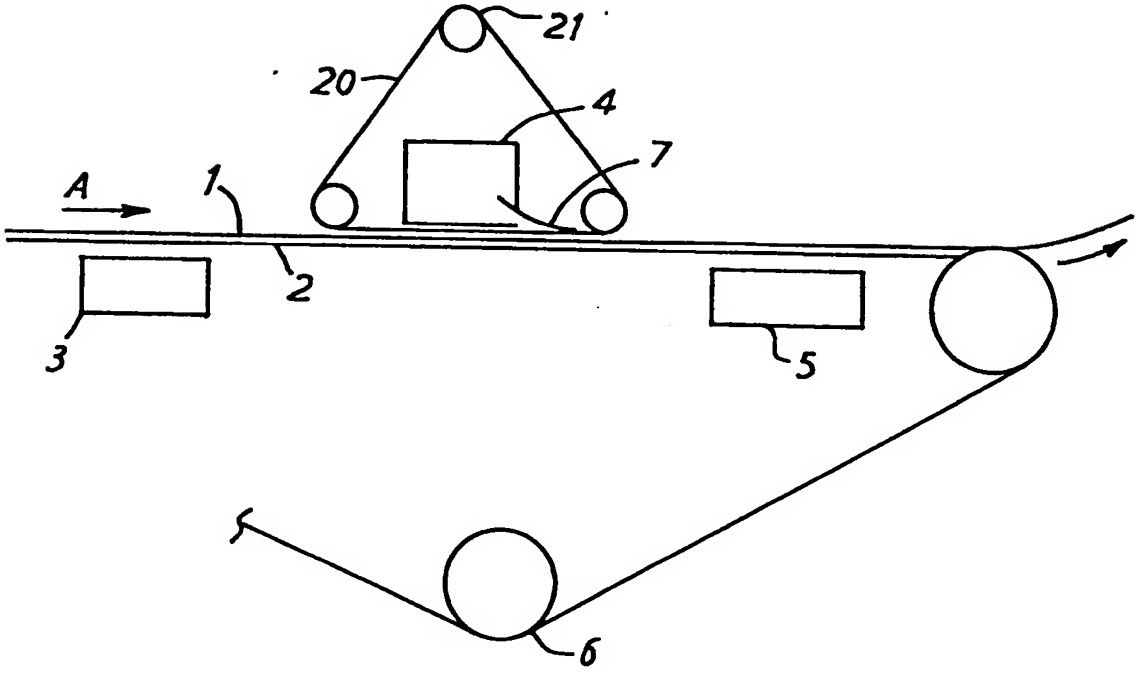
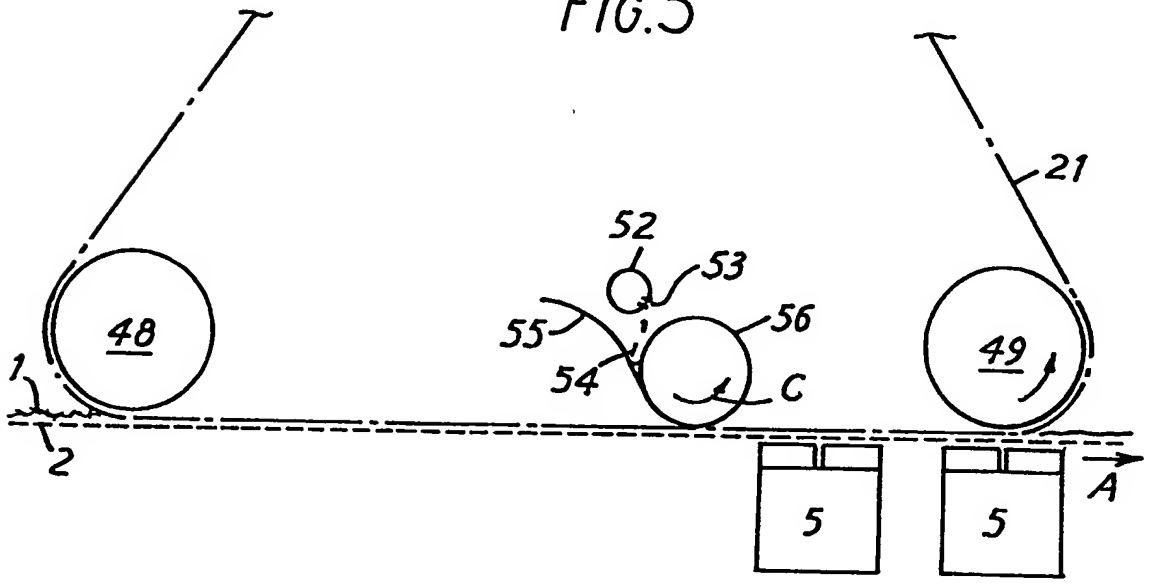


FIG.5



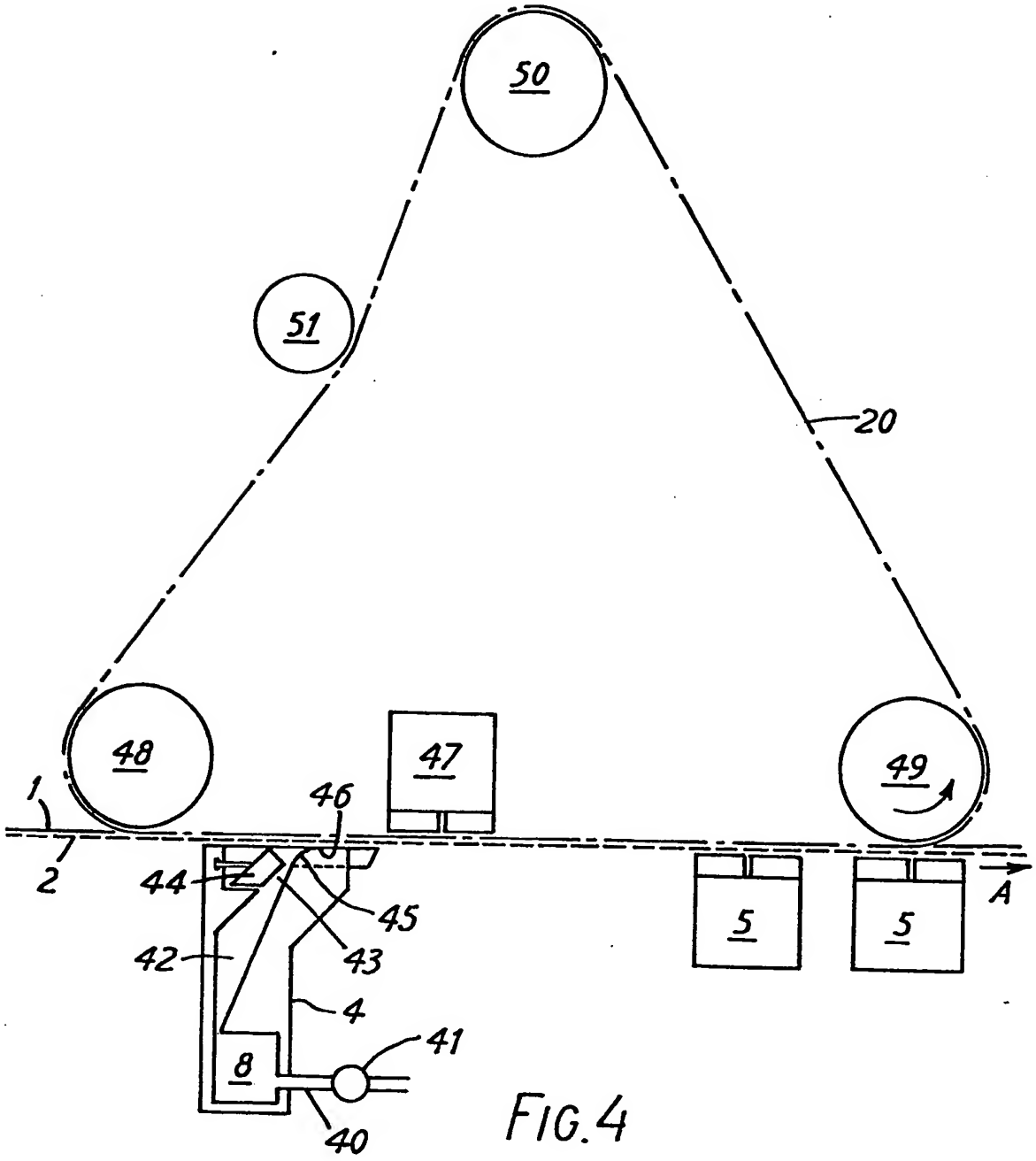


FIG.4

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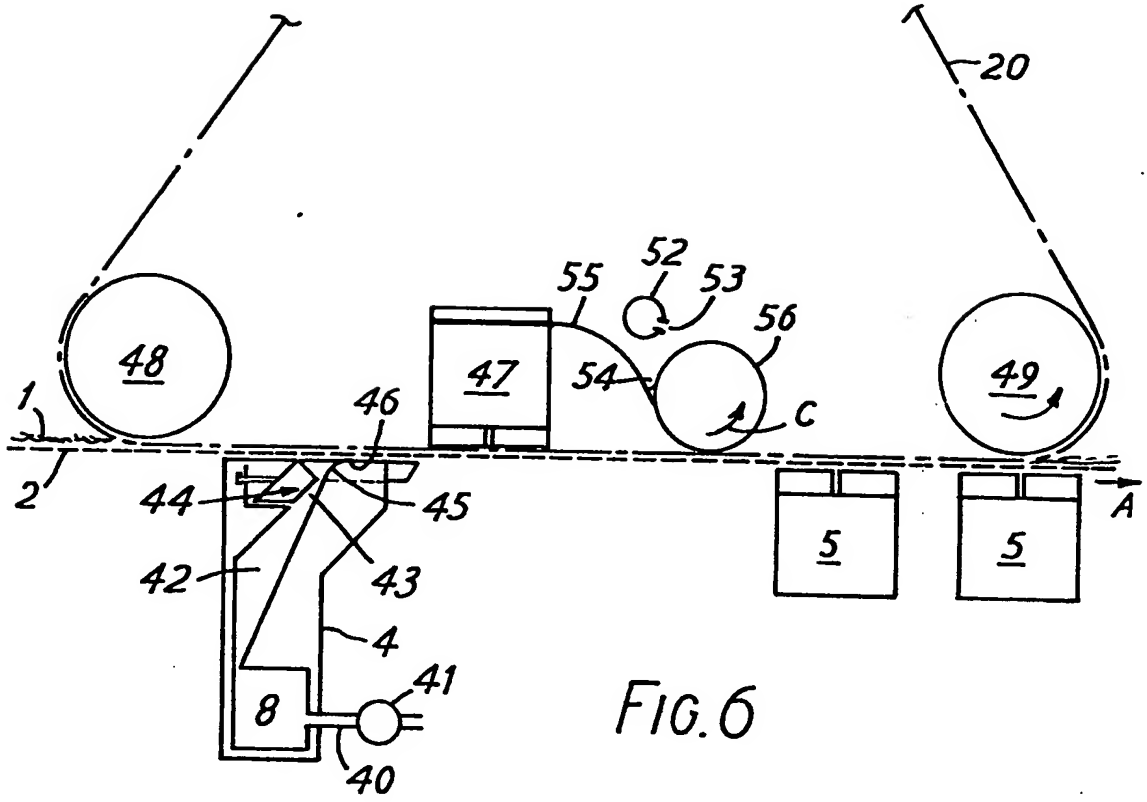

FIG.6

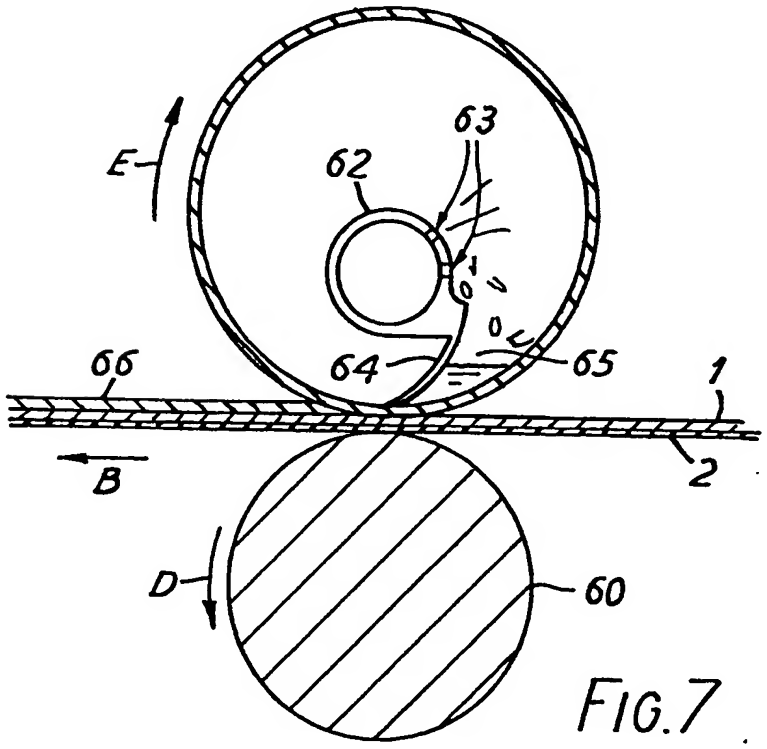

FIG.7

European Patent Office

EUROPEAN SEARCH REPORT

0180473

Application number

EP 85 30 7888

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
A	US-A-2 214 772 (G.D. MUGGLETON) * Whole document *	1-8,11,12,18,19,22,25,26	D 21 D 3/00
A	DE-C- 427 531 (B. KREMLER) * Figures 5,6; page 2, line 93 - page 3, line 34 *	1-8,11,12,14,18,19,21-23,25,26	
A	US-A-1 903 236 (B. JOHNSON) * Whole document *	1,4,7,12,13,22	
A	US-A-3 081 191 (J.W. SMITH et al.) * Figures 2,3; column 3, lines 1-27 *	1,12-17	TECHNICAL FIELDS SEARCHED (Int. Cl.4) B 05 C B 41 M D 21 D D 21 H
A	GB-A-1 589 280 (MONSANTO EUROPE) * Figure 2; claim 1; page 2, lines 25-93 *	19,20	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	10-01-1986	NESTBY K.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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